

Skeleton and Movement

We will begin by using a sock as a puppet. Take your socks and put your hand through it, as shown below:



Move your wrist up and down. Move your wrist so that it looks like the puppet is talking. Now keep your hand still, such that your fingers are stretched out in the sock.

Here are some more interesting glove puppets (puppets that are moved by putting in the hand inside).



Now think about - what are all the things from the list provided below that your hand is providing to the puppet, and click next. You can click more than one option.

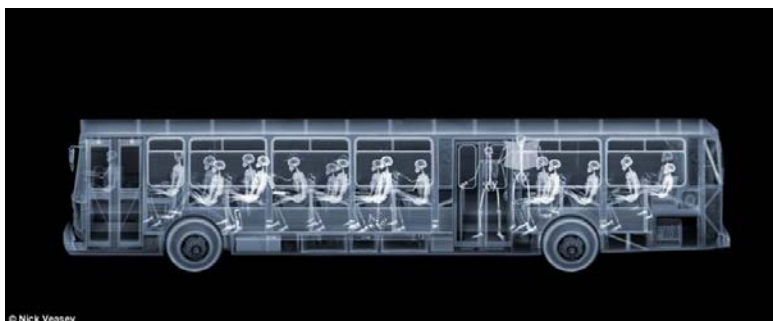
Softness, Shape, Beauty, Flavour, Structure, Support, Colour, Movement, Rhythm, Flexibility, Nothing, Something

Next

We think that shape, structure and support are the most important in the list.

We will have further look at puppets when we want to talk about movement.

Let us consider the following images:



Can you
identify a

common theme in these pictures? What are these X-ray pictures trying to show? Choose from the list below what sounds most appropriate to you:

a) Bodies b) Shapes c) Bones d) Framework e) Outlines

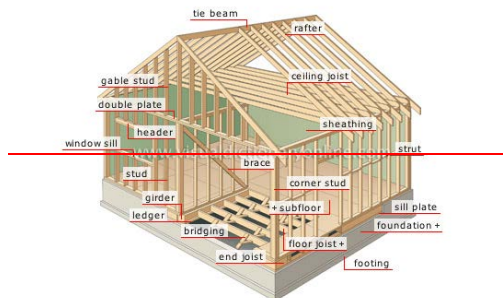
We think d) Framework is the most appropriate answer. Framework is defined as: a skeletal structure designed to support or enclose something.

The X-ray pictures clearly show this, whether it is a bony fish, a bat, a starfish, a crab or even a bus full of people.

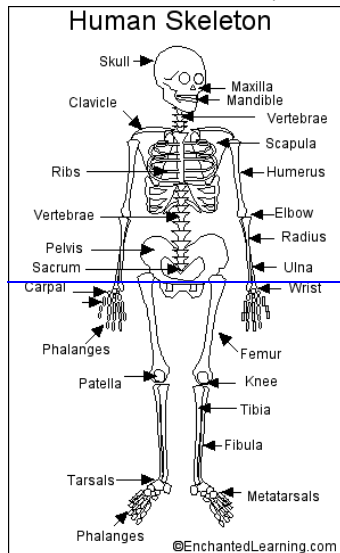
Feel your face, your arms and legs, your neck – can you feel something hard? Feel your stomach and cheeks? Do you feel a difference in the hard and soft parts of your body?

We know that the hard parts of our face, arms, legs, neck is provided by bones. These bones make up our framework.

What are other things where you can think of a framework? How about a house? Or even a building.



Similarly, the bones in our body make up our framework or skeletal system.

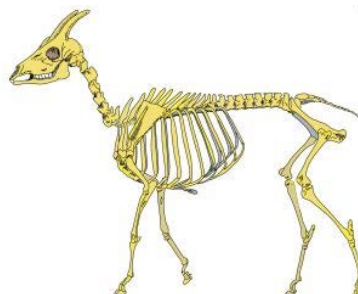
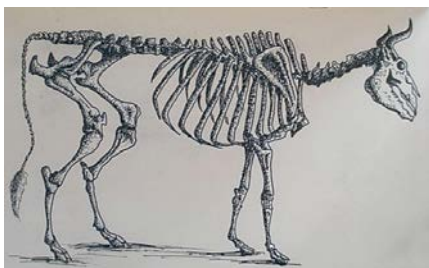


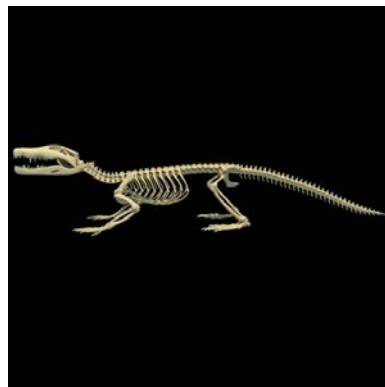
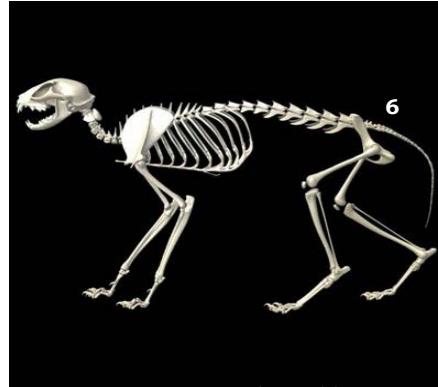
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+ 2" + 2.5" + 3" + 3.35" + 3.39"
+ 5.26"

Exercise

Here's an interesting exercise. Take a look at the following pictures. Can you guess the animal looking at each of these skeletons? Choose the right name and connect it to the animal.

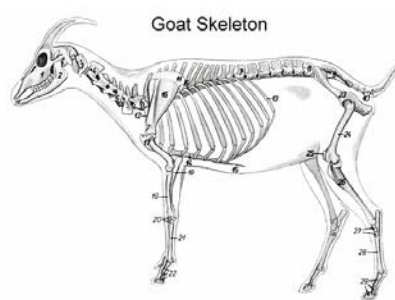
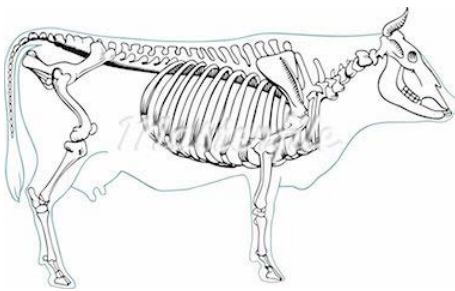
fish, frog, pigeon, mouse, rabbit, crocodile, lizard, goat, cow, cat, dog, snake, horse, whale and peacock.

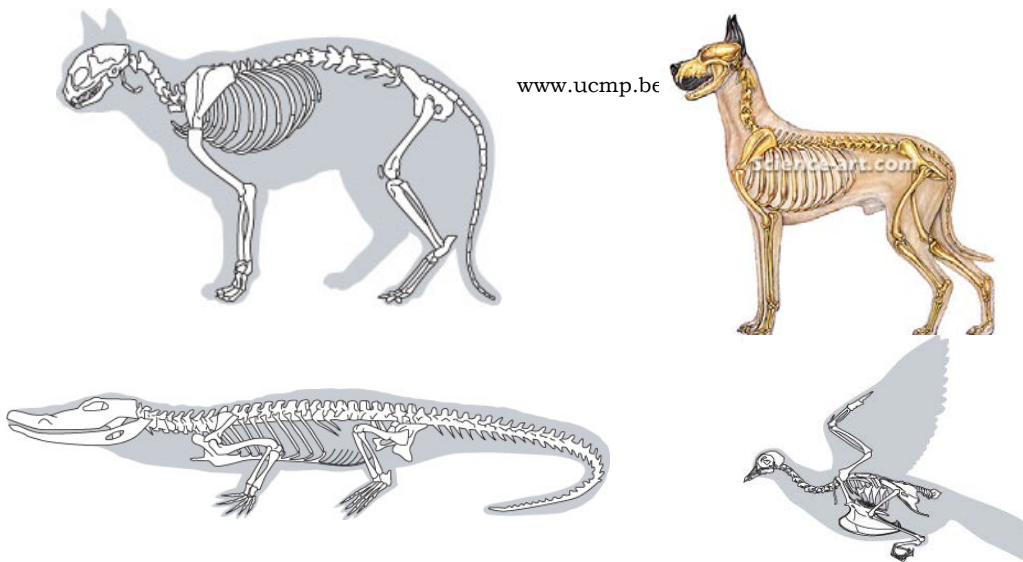




Answer: 1 – cow, 2 – goat, 3 – dog, 4 – cat, 5 – pigeon, 6 – crocodile.

Great! Now let us look at these organisms in their skin





Once again let us think about the hand puppet. What does our hand provide to the puppet? What does the skeletal system provide to all these organisms?

I think it provides shape and structure!



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Yes, it provides us with shape and structure, but one very important thing it provides is protection! It protects all our vital organs.

What do you think our skull protects?

Our head is made of a strong skull and this skull protects our brain.

The ribs present in our chest makes up the rib cage. What can the rib cage protect?

You may have guessed that the rib cage protects a number of important organs such as the heart, lungs, parts of the stomach, the spleen and parts of the kidney.



Let us now consider a different kind of organism like the earthworm. The earthworm has a specific shape, but does it have a skeletal system? What do you think?



How about a rhinoceros beetle? What about a starfish? Both the beetle and starfish have a specific shape and structure; but do these organisms have the skeletal system made of bones?
Yes/no



No, none of these have a skeleton.

Although these organisms have shape and structure, in these cases, the shape and structure is provided by the dermis (skin). In case of the earthworm, the muscles that line the skin of the organism give it shape and ability to move.

The beetles have a substance called chitin in the outer layer of the dermis. This chitin provides it with a hard exterior.

In the case of the starfish, the dermis contains calcium carbonate coat which gives it the hard exterior.



This hard exterior is known as the **exoskeleton** (exo=outside; a skeleton present on the outside of the body).

For beetles, starfish and other organisms such as crabs, prawns, etc., there is a hard exterior providing the framework to the body.

In our case, since our framework, the skeletal system is present *inside* our body, it is known as the **endoskeleton**. (endo=inside)

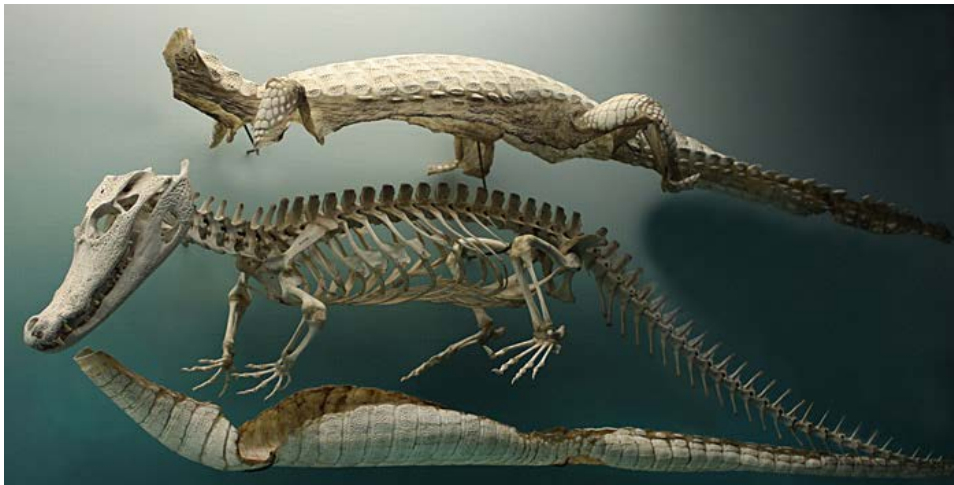
But can some animal have both an internal and external skeleton?

Out of the following, guess which animals can have **both** an exoskeleton as well as an endoskeleton:

snake, crocodile, honey-bee, rabbit, turtle, monkey, house-fly, alligator, cow, tortoise, bull, frog, goat

Crocodile, turtle, alligator, tortoise are these interesting creatures have both endo and exo skeletons!

As you can see in the picture below, the crocodile has an exoskeleton and an endoskeleton both!



Here comes another interesting question. Do you think bones are hollow or solid?

Solid/hollow

The interior of long bones, such as those that make up the arms (humerous, ulna, radius) and the legs (femur, tibia, fibula) is made up of soft tissue called bone marrow.

The bone marrow plays a very important role. It helps with the production of various components of blood cells, such as, red blood cells (RBC), platelets and white blood cells (WBC).

In addition to all these wonderful things, the bones of the skeletal system also play an important role in providing strength to the body. Bones are made up to calcium and phosphorus and therefore also serve as site of storage for calcium and phosphorus.

What makes the bones in the body move?

Let us consider a scary movie, one in which a skeleton is shown walking about scaring people. Now think if a skeleton could really walk by itself?



What makes the skeleton move? We will explore this question in this section.

The movement of spine

Let us consider the two images shown below. Which of these seems flexible to you?



Straight stick/ String of pearls

We can easily see that a string of pearls that can curve easily if required.

Of the two, the string of pearls and the rod, which one do you think is more like your spine?

Rod/Pearls

Can you think of the advantages of having a spine like a rod?

Now think of advantages of having it like a string of beads?



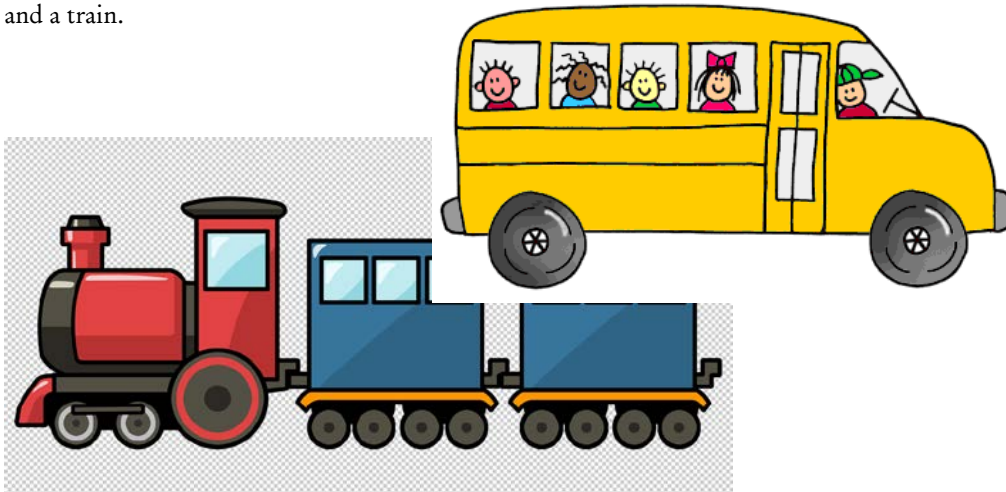
You would realize that a straight rod would be stiff, and hence would be able to hold itself up straight.

A string of beads would not be able to hold straight, but would allow flexibility of bending.

Would you be able to bend with a spine as stiff as a rod? Or stand straight with a spine as flexible as a string of beads? Probably not.

Our spine has to be combination of strength and flexibility. So neither the string of pearls nor the rod is like our spine. What we have is a combination.

To help see this, let us consider a bus and a train.



Think of the bus as a vehicle with a single large compartment and train with multiple compartments. On a straight path, the bus and the train may both move with equal ease.

What happens with when a bus and train are moving on a curving road?



Which of these two vehicles do you think moves with more ease on a curved path?

Train/Bus

The answer is the train.

A bus tends to be rigid with no flexibility in its shape, and hence has restricted movement. The train curves its body easily because of the 'joints' that connect one compartment to the other. The joints provide the train with the ability to move on curved roads and around cliffs. But notice the train is not really like a string of beads either, and won't make a full circle with its length. The compartment *edges* have shapes that fit with each other to provide the train with a degree of stiffness and flexibility both.



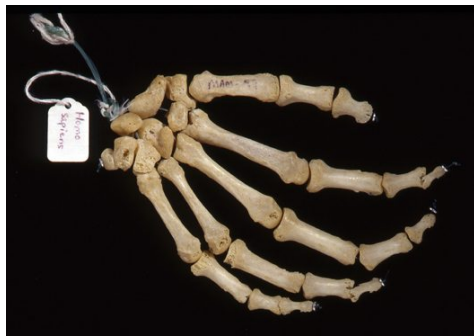
Our bodies' bones follow the principle of having smaller sections, like beads, but like the train, have special edges that fit into each other to provide various kinds of flexibility at different points.

Joints in the spine

Each vertebra (plural= vertebrae), which makes up the spine, is like a bead in the string. But it is not a round bead, but a bead with a shape that fits in a very special way to the next vertebra. This vertebra is made of strong bone and is connected through 'joints' to other vertebrae. This is why the spine is also called as the vertebral column.



See how the bones of our hand allow it to curl. Notice the edges of the small sections.



How do our joints move?

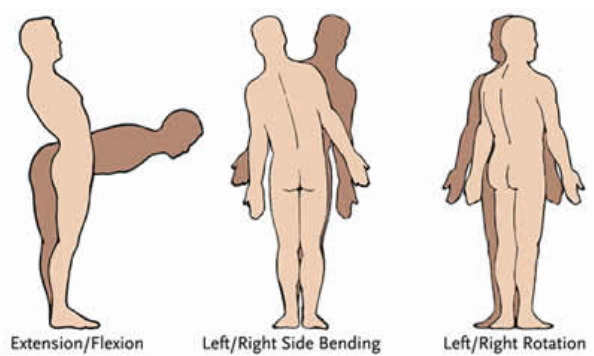
Here's another kind of puppet, a stick puppet. Notice that it is made of different stiff parts that are joined to each other through joints.



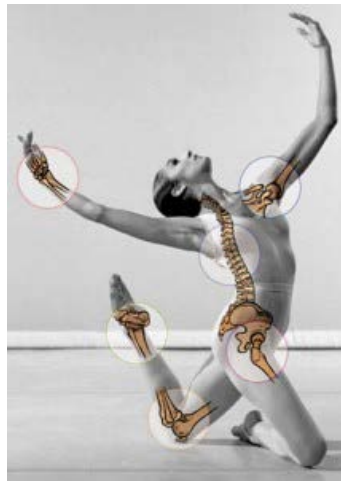
How does this puppet move its limbs? Think and click [next](#).

When someone pulls a limb with the help of a stick, the limb moves. The movement is possible because of the joint.

Look at the movements of a person. These movements are happening because our bones are moving at the joints.

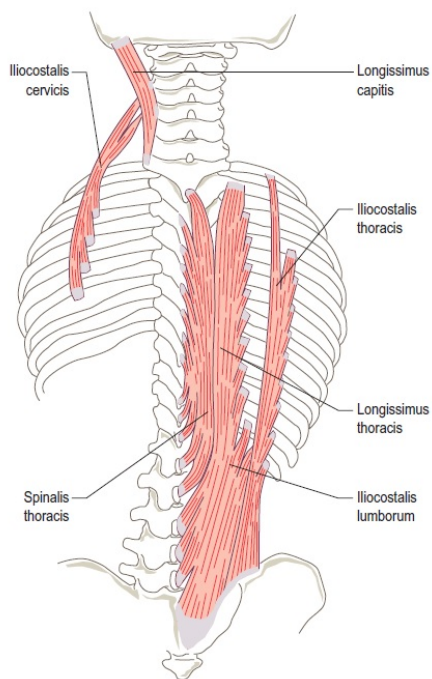


A joint is the place where two bones come together. These joints provide flexible connections between bones and enable movement, as shown in the picture.



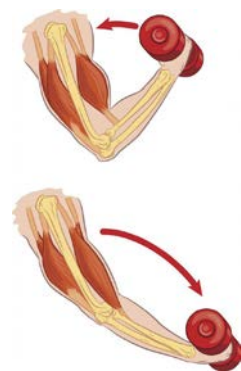
What do you think pulls at our bones so that they can move at the joint?

The answer is, the **muscles attached to bones**. The body can **contract** the muscles. The muscle length shortens and it pulls at its ends.

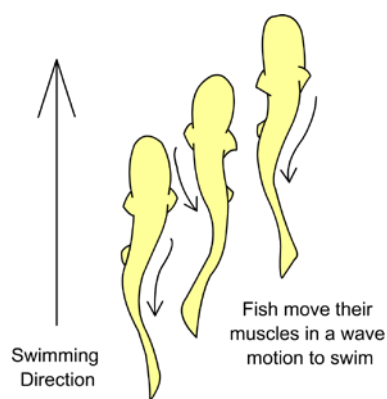
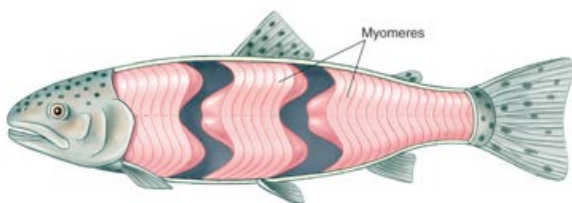


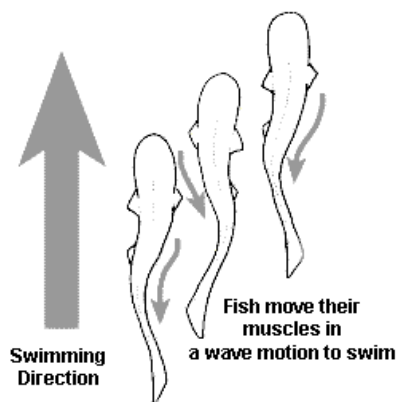
Muscles are a type of soft tissue in the human (or any animal body) that has the ability to contract, help with movement and help with the maintaining the position of various body parts.

See how muscles help in moving our arms.



Fish swim by flexing their bodies and tail back and forth. Fish stretch or expand their muscles on one side of their body, while relaxing the muscles on the other side. This motion moves them forward through the water.

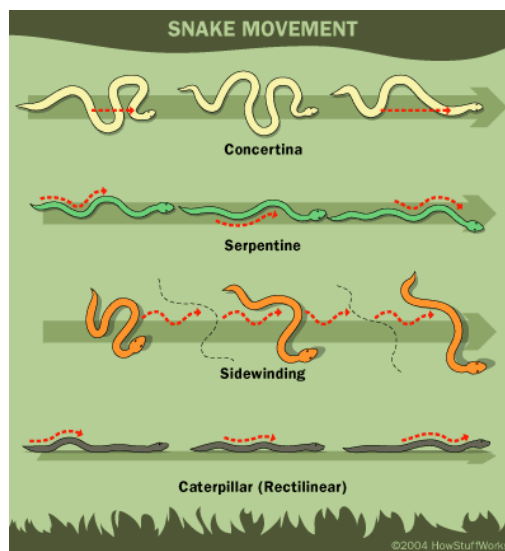




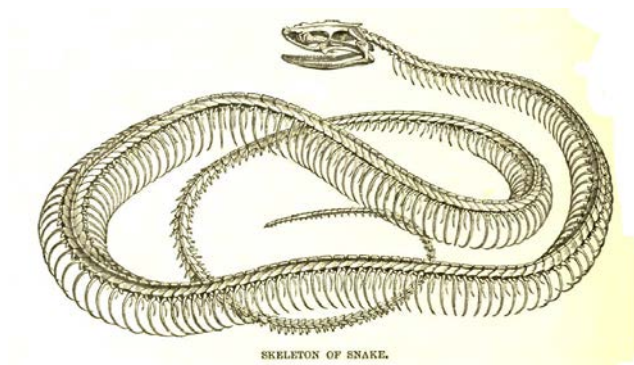
These examples show the role of muscles in movement. They apply force, supply the energy required. The bones provide the structure that moves. Movement happens because of the coordination of the muscles and skeletal system.

A snake and a caterpillar

A snake possesses a skeletal system. A caterpillar does not have one. Compare their movements in the picture below.



One can easily see the large variety of movements in the snake, which is possible because of the skeletal system. A snake can curve its body in multiple ways, in very tight curves with the help of hundreds of ribs in its vertebral column assisted by muscles.



So far we have talked about how skeletons and muscles work in other animals. Let us now see how it works in humans.

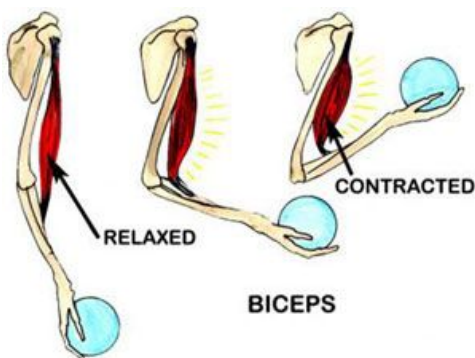
All movement in the body is controlled by muscles. There are some muscles in our body that work without us even thinking about it - for instance, our heart beating. These are the *involuntary* muscles.

Then there are those muscles which we can consciously control. These are *voluntary* muscles.

For example, when you want to scratch your nose or want to reach out for a glass of water or want to walk across the room, you command your muscles to move according to your wishes. Basically, we just have to think about walking or running or reaching for something and our brain sends commands to the relevant muscles!

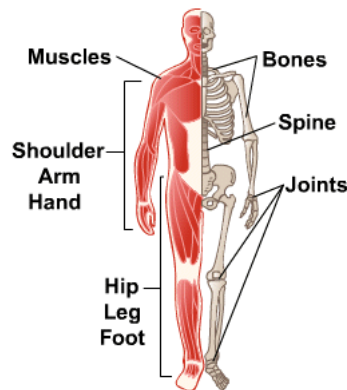
How do muscles work?

Let's take the example of a person wanting to lift a ball. Her biceps contract to pull and lift the lower part of the arm up.

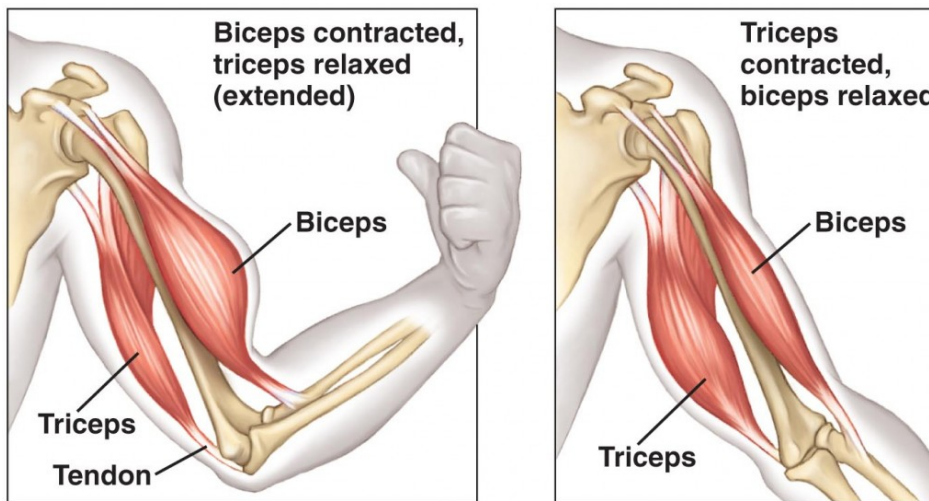


Like the biceps, all muscles work by contracting and relaxing.

Muscles are made of thin, long cells that are grouped in bundles known as fibres. The muscles fibres contract or relax based on signals coming from the brain through nerves – the living cells in the muscles release energy to either contract or relax the muscle.



One muscle can pull in one direction. Notice that for movement in opposite direction, the same muscle will not work, since *muscle tissue can only contract, not stretch by itself*. So there is another muscle to make the opposite movement possible



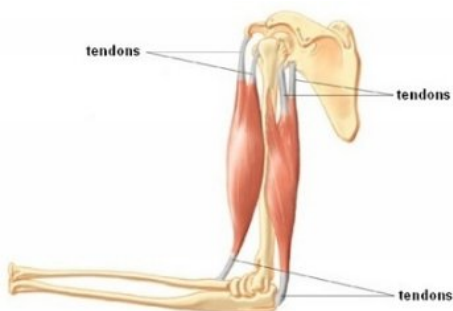
So certain muscles work in pairs - such as those shown below, the biceps and triceps.

Working in pairs helps with an array of movements - when we want to bend our arm the biceps contract and the triceps relax. Alternately, when we want to straighten the arm - then the triceps contract and biceps relax. Try it out, touch your muscles and see if you can feel different muscles move with different movements.

Types of muscles

All the muscles in our body are not the same. This is because different muscle groups in our body have different functions.

For instance, of the three different types of muscles, the **skeletal muscles** are the main muscles that cover the skeleton and are used to move around. These are voluntary muscles. The soft skeletal muscle tissue is connected to the hard bone by rope like, thin **tendons**.



Next we have the **smooth muscles** - these do not connect to the bones. These are the muscles that control organs in our body. For example, muscles in the lungs that control breathing. These are involuntary muscles.

And finally, a special type of muscle, the **cardiac muscle**, an involuntary muscle that pumps the heart and circulates the blood through the body.

Interesting facts about muscles:

Which is the strongest muscle in our body? (a) neck muscles (b) chest muscle (c) stomach muscle (d) jaw muscle

The correct answer is (d) the muscles in our jaw.

Do you know how many muscles it takes to smile and to frown? (a) 43, 17 (b) 34, 71 (c) 17, 43 (d) 71, 34

The correct answer is (c) 17 to smile and 43 to frown. Did you know that shivering is caused by hundreds of muscles expanding and contracting to produce heat and make us warm?

Types of joints

Joints in the human body are of two main types - fixed or moving.

Can you think of an example of a joint that doesn't move? Think and click [next](#).

The skull is an example of fixed joints, each of the sutures (as shown in the figure) are fixed in place.



The moveable joints are the ones that allow us to twist, bend, and move various parts of our body.

Look at your hand and fingers. Can you guess how many moveable joints it has?

To understand the flexibility of the hand, let us do a small exercise. Get some sticks like the kind you get with a ice cream cups. Tape the sticks to your fingers and try some basic movements. Such as writing, tying your shoe laces, or eating the ice cream. Can you do these exercises with ease? They are difficult when the finger joints are tied! Now remove the sticks and do all the activities, to find that they are easily done.

The bones in the hand are much closer to a string of small beads, which allow the hand enough flexibility to curl up in a fist.



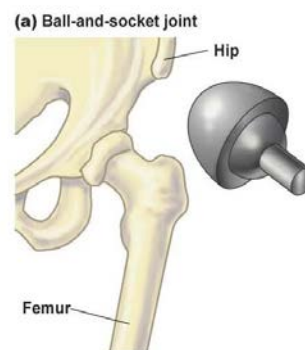
Notice that our arms cannot curl up like our palms can, because of fewer numbers of moveable joints.

Many kinds of moveable joints

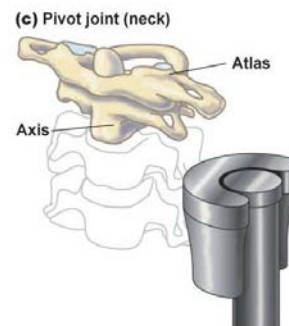
Moveable joints are not all similar. They have very interesting shapes that allow for less and more movements.

The moveable joints are shown below. While reading about the joints you could move them as you locate them in your body.

1. Ball and socket joint: This consists of a ball shaped end of one bone fitting into a small like cuplike socket of another bone. Allows for movements in any direction, including rotation. E.g. joint between the arm and the shoulder and joint between the leg and hip.



2. Pivot joint: This occurs when the rounded surface of one bone fits into the ring of another bone or tendon (a tough band of connective tissue - usually connects muscle to bone) allowing for rotation. E.g. wrist, neck and ankles.



3. Saddle joint: occurs in the touching surfaces of two bones, such that the bones complement each other. Although this joint provides a wide range of motion, in humans it is found only in the thumb.

saddle joint



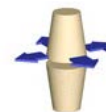
4. Hinge-joint: occurs when the convex projection of one bone fits into the concave projection of another bone. Allows movement in a single plane - flexing (fold your knee and elbow) and extending (extend your knee and elbow). To look at a hinge joint observe how your doors and windows are joined to their frames.

(b) hinge joint (knee)

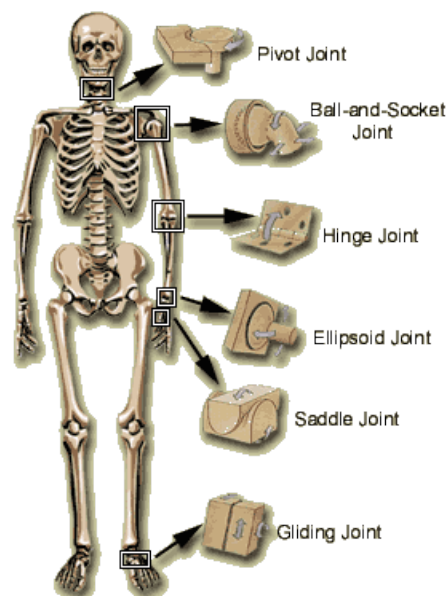


5. Gliding joints: occurs when the flat surface of one bone moves against another allowing sliding and twisting. The joint is found in the carpal bones of the wrist and tarsal bones of the ankle.

gliding joint



In the carpal bones it is called as the ellipsoid joint and in the tarsal bones it is called as the plane joint.



Do you know how many moveable (& semi-moveable joints) there are in your body?

There are 230 moveable and semi-moveable joints in the entire body!

Some fun facts about bones:

Where are the smallest bones of the body located?

Bones in the ear are the smallest.

The spine is made up of 33 bones.

The number of bones (vertebrae) in the neck of the human body is the same as in the neck of a giraffe. The difference is that the bones in the giraffe's neck are a lot bigger.

Bones in our body stop growing around the age of 20, but new bone cells are constantly built.

Functions of the skeleton system

The skeleton does many things for our body.

Giving shape

Bone structure gives shape to the body. This shape changes as we grow, and our skeletal system determines our height, width and other factors, such as the size of your hands and feet.



Giving support

The skeleton provides support to the body and keeps internal organs in their proper place. The vertebral column allows us to stand erect, while cavities – hollow spaces in the skeleton hold our organs. For example, the skull holds the brain, the chest cavity holds the lungs and heart, while the abdominal cavity holds the digestive tract. The thick and strong pelvis and leg bones support the weight of the entire skeleton.



Makes movement possible

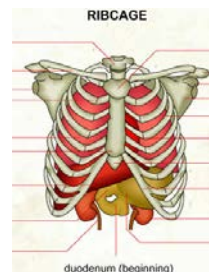
The muscular and skeletal systems work together to carry out bodily movement. When muscles contract, the skeleton moves.

The shape of the skeletal system also impacts movement. The small bones of the foot allow for adaptation to all sorts of terrain, while the small bones in the hands allow for precise and detailed movement.



Gives Protection

The skeleton protects vital organs from damage, encasing them within hard bones. The skull protects the brain. The vertebral column protects the delicate spinal cord, which controls all bodily functions through communication with our brain. The bony thorax, comprised of the ribs, protects our heart and lungs.

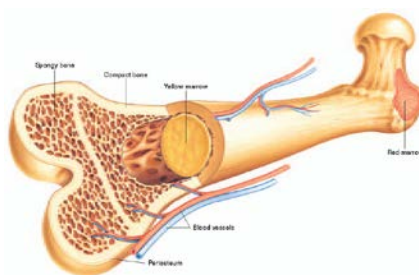


Blood Cell Production and Storage

The spongy tissue inside long bones, such as the thigh bone, has two types of marrow responsible for blood cell production. Red bone marrow gives rise to blood cells while yellow bone marrow stores fat, which turns into red bone marrow in case of severe red blood cell depletion or anemia.



Skeletal bones also function as a storage bank for minerals, such as calcium and phosphorus. These minerals are necessary for vital body functions



The following videos summarize the structure and function of the skeletal system:

<https://www.youtube.com/watch?v=iGVzD4soDMo>

<https://www.youtube.com/watch?v=UPrxQkjExI>

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